


FORM PTO 1390 (REV 5-93)		US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY DOCKET NUMBER 2000_1716A
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. §371			U.S. APPLICATION NO. (if known, 37 CFR 1.53) 697719854
International Application No. PCT/JP00/02541 ✓	International Filing Date April 19, 2000 ✓	Priority Date Claimed April 19, 1999 ✓	
Title of Invention PURIFYING APPARATUS			
Applicant(s) For DO/EO/US Takaaki MAEKAWA et al. ✓			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<p>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. §371.</p> <p>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. §371.</p> <p>3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. §371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. §371(b) and PCT Articles 22 and 39(1).</p> <p>4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. §371(c)(2))</p> <p style="margin-left: 20px;">a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</p> <p style="margin-left: 20px;">b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau. ATTACHMENT A</p> <p style="margin-left: 20px;">c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)</p> <p>6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. §371(c)(2)). ATTACHMENT B</p> <p>7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3)).</p> <p style="margin-left: 20px;">a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</p> <p style="margin-left: 20px;">b. <input type="checkbox"/> have been transmitted by the International Bureau.</p> <p style="margin-left: 20px;">c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p style="margin-left: 20px;">d. <input type="checkbox"/> have not been made and will not be made.</p> <p>8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19.</p> <p>9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. §371(c)(4)).</p> <p>10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. §371(c)(5)).</p> <p>Items 11. to 14. below concern other document(s) or information included:</p> <p>11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. ATTACHMENT C</p> <p style="margin-left: 20px;"><input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</p> <p>14. <input checked="" type="checkbox"/> Other items or information:</p> <p style="margin-left: 40px;">- <u>unexecuted</u> Declaration and Power of Attorney with Cover Letter - ATTACHMENT D</p>			
<p>THE COMMISSIONER IS AUTHORIZED TO CHARGE ANY DEFICIENCY IN THE FEES FOR THIS PAPER TO DEPOSIT ACCOUNT NO. 23-0975</p>			

U.S. APPLICATION NO. <b>09/719854</b> <small>(of 1,200,000, 37 CFR 1.53)</small>		INTERNATIONAL APPLICATION NO. PCT/JP00/02541		ATTORNEY'S DOCKET NO. 2000 1716A					
15. [X] The following fees are submitted  <b>BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):</b> Neither international preliminary examination fee nor international search fee paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1000.00 International Search Report has been prepared by the EPO or JPO ..... \$ 860.00 International preliminary examination fee not paid to USPTO but international search paid to USPTO ..... \$ 710.00 International preliminary examination fee paid to USPTO but claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$ 690.00 International preliminary examination fee paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$ 100.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 50%;">CALCULATIONS</th> <th style="width: 50%;">PTO USE ONLY</th> </tr> <tr> <td style="height: 100px;"></td> <td></td> </tr> </table>		CALCULATIONS	PTO USE ONLY		
CALCULATIONS	PTO USE ONLY								
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$					
Claims	Number Filed	Number Extra	Rate						
Total Claims	25 - 20 =	5	X \$18.00	\$ 90.00					
Independent Claims	1 - 3 =	-0-	X \$80.00	\$					
Multiple dependent claim(s) (if applicable)				+ \$270.00 \$					
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$950.00					
<input type="checkbox"/> Small Entity Status is hereby asserted. Above fees are reduced by 1/2.				\$					
<b>SUBTOTAL =</b>				\$950.00					
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				+ \$					
<b>TOTAL NATIONAL FEE =</b>				\$950.00					
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40 per property +				\$					
<b>TOTAL FEES ENCLOSED =</b>				\$950.00					
				Amount to be refunded	\$				
				Amount to be charged	\$				
a. [X] A check in the amount of <u>\$950.00</u> to cover the above fees is enclosed. A duplicate copy of this form is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. 23-0975 in the amount of \$_____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>23-0975</u> .									
<b>NOTE:</b> Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.									
16. CORRESPONDENCE ADDRESS   <div style="text-align: center;">   <b>000513</b>          PATENT TRADEMARK OFFICE       </div>				By: <u>Charles R. Watts</u> Charles R. Watts Registration No. 33,142  WENDEROTH, LIND & PONACK, L.L.P. 2033 "K" Street, N.W., Suite 800 Washington, D.C. 20006 Phone: (202) 721-8200 Fax: (202) 721-8250  December 18, 2000					

[CHECK NO. 41205]

[2000\_1716A]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of :  
Takaaki MAEKAWA et al. : **Attn: APPLICATION BRANCH**  
Serial No. NEW : Docket No. 2000\_1716A  
Filed December 18, 2000 :  
**PURIFYING APPARATUS**

**PRELIMINARY AMENDMENT**

Assistant Commissioner for Patents,  
Washington, DC 20231

Sir:

Please amend the above-identified application as follows.

**In the Claims:**

Kindly amend claims 3, 5-13 and 15-25 as follows.

Claim 3, line 1, delete "or 2";

Claim 5, line 1, delete "or 4";

Claim 6, line 1, change "of any of claims 1 to 5" to --of claim 1--;

Claim 7, line 1, change "of any one of claims 1 to 6" to --of claim 1--;

Claim 8, line 1, change "of any one of claims 1 to 7" to --of claim 1--;

Claim 9, line 1, change "of any one of claims 6 to 8" to --of claim 6--;

Claim 10, line 1, change "of any one of claims 7 to 9" to --of claim 7--;

Claim 11, line 1, change "of any one of claims 6 to 10" to --of claim 6--;

Claim 12, line 1, change "of any one of claims 1 to 11" to --of claim 1--;

Claim 13, line 1, change "of any one of claims 1 to 12" to --of claim 1--;

Claim 15, line 1, change "of any one of claims 2 to 14" to --of claim 2--;

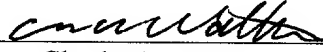
Claim 16, line 1, change "of any one of claims 1 to 15" to --of claim 1--;  
Claim 17, line 1, change "of any one of claims 2 to 16" to --of claim 2--;  
Claim 18, line 1, change "of any one of claims 1 to 17" to --of claim 1--;  
Claim 19, line 1, change "of any one of claims 1 to 18" to --of claim 1--;  
Claim 20, line 1, change "of any one of claims 1 to 19" to --of claim 1--;  
Claim 21, line 1, change "of any one of claims 1 to 20" to --of claim 1--;  
Claim 22, line 1, change "of any one of claims 3 to 21" to --of claim 3--;  
Claim 23, line 1, change "of any one of claims 1 to 22" to --of claim 1--;  
Claim 24, line 1, change "of any one of claims 2 to 23" to --of claim 2--;  
Claim 25, line 3, change "any of claims 1 to 24" to --claim 1--.

#### REMARKS

The above claim amendments are presented to remove multiple claim dependency, so as to reduce the required filing fee.

Respectfully submitted,

Takaaki MAEKAWA et al.

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5/PRTS

## PURIFYING APPARATUS

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention:

The present invention relates to a purifying apparatus for flowing water. More detailedly, the invention relates to a purifying apparatus by oxidation and decomposition of water pollution substances in a river, which is effective for use such as elimination of nitrogen and phosphorous which are cause substances of eutrophication of the river flowing water.

## 2. Description of the Related Art:

Hitherto, in regard to a purification of the water pollution substances in the river, although a contact oxidation method by a biological membrane having a membrane in which microbes living in the river naturally grow has been developed and applied, this method is suitable mainly to purify carbon sources contained in a waste water, but it is not suitable to eliminate nitrogen and phosphorous which are cause substances of eutrophication.

Therefore, in prior arts, in order to prevent the eutrophication it is necessary to decompose and eliminate nitrogen and phosphorous other than the carbon sources, so that the biological membrane treatment method is not necessarily sufficient. Further, there have been studied about countermeasures such as a nitrification/denitrification by a

## SUMMARY OF THE INVENTION

As one for achieving the above object the invention provides a purifying apparatus for flowing water in which a negative electrode plate is disposed on a flowing water bed and a positive electrode plate is disposed in an upper face oppositely to the negative electrode plate, characterized in

The invention intends to solve the problems by means of generating O-radical (oxygen radical) and OH-radical (hydroxy radical), which are generated by the high electric field pulses and have a high oxidizing power, on a metal face for nanosecond to microsecond, oxidizing mainly a carbon source and a nitrogen source in a polluted water, which impinge against these radicals, and cohering phosphorous by a cohesive reaction of particles in accompaniment with an electrification of  $H^+$  ions generated on this occasion to floating suspended substances so as to sediment and separate the phosphorous, thereby achieving by one pass operation an elimination of the pollution substances at 90 - 95% which could not be attained by the prior art.

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level and a flow rate of the flowing water change together with a structure of the purifying apparatus, in order to cope with this, the fact is taken into consideration that it is necessary to automatically control a supplied watt-hour by the flow rate of the water and a concentration of SS such that it becomes a suitable optimum watt-hour to thereby maintain the elimination rate of the pollution substances constant. For example, since the flowing water in water river greatly changes depending on time during one day and a ratio between when the flow rate is minimum and when it is maximum reaches 1 : 10 - 20, it follows that a magnitude of the flow rate is proportional to a passing velocity, so that, in order to supply an electric power tracing the magnitude of the flow rate, it is necessary to adjunctively provide a control unit for adjusting the supplied watt-hour which is optimum and minimum with respect to the flow rate, the floating suspended substances and a water depth. Further, in an emergency time such as a flood, the present apparatus must be provided for being shunted so as not to become an obstacle in the flowing water.

Therefore, first, in a structure of the purifying apparatus of the invention, the following modes are taken into consideration as being suitable ones, although not limited to these.

< 1 > In the positive electrode plate, there is provided means for vertically moving it.



< 2 > Gas collecting means (for collecting a gas generated by oxidation and decomposition) is provided.

< 3 > The positive electrode plate has at least one positive electrode substance among metals (including alloys; hereafter, ditto) and metal oxides.

< 4 > The positive electrode plate is composed, for example, of a base plate which is metal, ceramics or resin or a composite body of more than two of the formers, and of the positive electrode substance.

< 5 > The positive electrode substance is at least one of, for example, titanium oxide, ruthenium oxide, cobalt oxide, nickel oxide, tin oxide and platinum.

< 6 > In a more concrete example, in the positive electrode plate, at least one of titanium oxide, ruthenium oxide, cobalt oxide, nickel oxide, tin oxide and platinum is integrated with a plate of porous titanium, porous ceramics or stainless.

< 7 > The positive electrode plate is adapted such that its dipped depth from a water surface is  $1/5 - 1/10$  of a water depth.

In the invention adapted such that the water pollution substances contained in the flowing water are oxidized and decomposed by the generation of high electric field pulses, how the positive electrode plate should be constituted is practically a very important point in order to make the

generation of high electric field pulses and actions of the aforesaid radicals by the generation effective ones. More suitably, in the invention, as the positive electrode substance, the metal oxide or a noble metal is used. Such a metal oxide called titanium oxide, ruthenium oxide, cobalt oxide, nickel oxide or tin oxide, or platinum as mentioned above is effective.

As to the positive electrode substance, in case where it is the metal oxide, it may be one formed by making its particles into a green compact and baking or sintering it, or one in which the substance or its particles is/are born on a suitable base plate. As the base plate for bearing on this occasion, it may be, for example, a plate of porous titanium, porous ceramics or stainless etc., which has a high corrosion resistance, and it is preferable that the positive electrode substance constitutes a positive electrode face portion in a membrane-like form. The base plate itself may be made conductive, or the positive electrode substance in the membrane-like form may be caused to have a conductive property.

The metal oxide may be integrated with the base plate by an adhesion-integration by deposition, distillation and the like, or means such as application of a gel solution.

In case of platinum, a surface plating may be adopted, or a platinum foil may be adhered.

Incidentally, as to a negative electrode, various

substances may be adopted so long as they are metals having a high corrosion resistance or ones whose surfaces are coated with the metals. For example, a stainless plate and a metal plate coated with the platinum foil are exemplified.

It is practical that the positive electrode is adapted to be dipped from the water surface by vertically moving means and, further, it is desirable that the positive electrode plate is provided in its vicinity with gas collecting means.

Further, it is preferable in the invention that the positive electrode plate has a concave curved face opposite to the negative electrode in viewpoints of generating the high electric field pulses and collecting a decomposed gas.

Concretely exemplifying and explaining, for example, in the purification apparatus by oxidation and decomposition of the invention, the stainless plate or the metal plate coated with the platinum foil is made the negative electrode; titanium oxide, ruthenium oxide, cobalt oxide, nickel oxide, tin oxide or the platinum foil is adhered to an upper face of die-cast plate etc. of conductive porous titanium or stainless parallel in face to the metal plate; one in which the aforesaid upper face is slightly curved in a concave state relative to the negative electrode is made the positive electrode plate; floats are attached to the positive electrode plate at its front and back; there is provided a structure in which the positive electrode plate is dipped to  $1/5 - 1/10$  of a water depth; and

there is provided a structure in which the floats are vertically movable at four corners of the positive electrode plate. Further, a sealing is applied in order to prevent a gas generated by the decomposition from escaping, and a gas reservoir is provided, thereby making it possible to collect the generated gas.

And, it is preferable that the purifying apparatus of the invention is adapted such that the water flow impinges against an oxidizing electrode face (positive electrode plate) under a turbulent flow state by high electrode field pulse waves, and an oxidizing reaction of pollution substances continues for at least 2 - 3 seconds. Further, as mentioned above, it is desirable to prevent the gas generated by oxidation and decomposition from being discharged into the air. Since the oxidizing reaction occurs by a physicochemical reaction,  $N_2$  and  $NO_x$  are generated in regard to N source, noxious gasses of  $SO_x$  and  $H_2S$  are generated in regard to S source, and  $CO_2$  gas is mostly generated and CO gas is slightly generated in regard to C source. It is desirable that these intermediate products are reduction-treated by hydrogen and the like. Treating means and treating unit therefor are also proposed in the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1a is a side sectional view showing a constitution

of a purifying apparatus of the invention;

Fig.1b is a front sectional view showing the same;

Fig.2a is a side sectional view showing an example having an electric field control mechanism;

Fig.2b is a front sectional view showing the same;

Fig.3 is a side sectional view showing an example having a cleaner mechanism;

Fig.4 is a constitutional view showing an example having a gas catalyst oxidation unit; and

Fig.5 is a constitutional view showing an example having a sediment collecting unit.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, next, it is further explained about an implementation mode of the invention along the drawings. First. Fig.1a is a lateral sectional view showing main portions of a constitution of the purifying apparatus of the invention, and Fig.1b a front sectional view showing the same. A positive electrode plate is constituted as one in which a conductive porous metal (A) such as titanium for instance is made a base plate and to which there is integrally applied an oxide electrode or a platinum electrode (B), which consists of an oxide such as titanium oxide, ruthenium oxide, cobalt oxide, nickel oxide or tin oxide or platinum. Plural electrodes (B) are disposed orthogonally to a flowing direction ( $\alpha$ ) of the

flowing water.

The positive electrode mentioned above is adapted such that it floats by air floats (F) utilizing buoyancies of air reservoirs disposed back and forth in the flowing direction ( $\alpha$ ), and moves up and down by movable crowns (h).

The movable crown (h) is adapted such that its position is detected by a differential transformer (I).

And, in the example of Fig.1, there is adopted a structure in which a seal plate (D) as means for gas seal is integrally arranged on a back face of the porous metal (A) as the base plate constituting the positive electrode plate, a gas reservoir (C) is mounted at a downstream side of the positive electrode, and a gas generated in a surface of the electrode (B) is collected into the gas reservoir (C) directly or after entering into the porous metal (A) and discharged by a gas collecting pump (P). As shown in Fig.1b, the electrode (B) has a concave shape in section, thereby making it possible to easily collect the generated gas. Further, a turbulent flow generating plate (G) is placed on a surface of a negative electrode plate (E) in order to maintain the turbulent flow, and thus it is adapted such that an oxidation/decomposition efficiency is enhanced by making it easy to generate the turbulent flow.

And, by the differential transformer provided in the movable crowns (h) as vertically moving means, it is adapted

such that a voltage between the positive electrode plate and the negative electrode plate is changed between 200 V/cm and 10 KV/cm. Further, a turbidimeter (Tu) as a concentration detector is provided in front of the flow, and an electric current is changed between 1 mA and 100 mA in compliance with the concentration. Further, a flow velocity meter (V) is arranged in a similar manner and, from the flow velocity, a frequency is changed between 10 kHz and 150 kHz. By such an automatic control mechanism, it follows that the oxidation and decomposition complying with a load amount of the water pollution is effectively performed. As to the automatic control mechanism, it is possible to further exemplify.

For example, like Fig.2a and Fig.2b, it is adapted such that positions of plus and minus are detected by the differential transformer (I), the flow rate is detected by the flow velocity meter (V), an SS amount is detected by the turbidimeter (Tu), a control unit (CPU) and an electric field generating unit (PA) are used, and these are made possible to perform controls of a voltage, a frequency, a pulse timing and a duty ratio by digital controls always as an optimum electric field treatment.

For example, in such examples of the invention as mentioned above, as shown also in Fig.1b and Fig.2b, the purifying apparatus is disposed within a width between side walls ( $\beta$ ) such as concrete. It is practically desirable to

dispose it in this manner.

And, in the oxidation/decomposition purifying apparatus of the invention, like Figs.1a, 1b and Figs.2a, 2b, as a suitable one there is shown one having a structure in which plural turbulent flow generating plates (G) each having a metal made protrusion are placed on the negative electrode plate (E) such that the water flow forms the turbulent flow with its height being limited to 10 - 15% of a distance between the electrode plates.

It is considered to make a backward angle of the protrusion about 20 - 40 degrees, and to dispose about 2 - 10 protrusions in the flowing direction of the water flow.

Further, in the river, since it is considered that suspended substances, sands and gravel enter into the apparatus, and in order to prevent an electrode face from deteriorating by the fact that the SS concentration is high, it is preferable, like Fig.3, to periodically perform a cleaning of the electrode face by a brush and a water jet by means of an automatic control. Further, at a flood time, since an outflow becomes larger than a planned water amount, it is effective to apply a provision for drawing up the plus electrode from an inside of the water, thereby immediately stopping loads of pulse waves.

Furthermore, in order to decompose a noxious gas such as NOx, SOx and H2S, like Fig.4, it is possible to reduce the



gas by means of a catalyst (d) by mixing the gas in a gas mixing unit (C) with hydrogen generated by an electrolysis of the water or hydrogen supplied from an H<sub>2</sub> bomb (B), thereby intending to prevent the noxious gas from generating.

As a countermeasure for the flood time, it is desirable that, when the electrode has floated above a set water level as shown in Figs.1a and 1b, the electrode is lifted above the water surface by an electric motor to thereby intend a safety of the apparatus.

And, further, the SS is sedimented by, for example, a high electromagnetic treatment, and the phosphorous and the SS in the polluted water can be eliminated in 80 - 90% by means of gravity-sedimenting them by providing in a downstream side a sedimentation tank through a bypass system by a pump or a direct system and returning a supernatant liquid to the original river (Fig.5).

Now, hereunder, the invention is more detailedly explained about embodiments.

#### < Embodiment 1 >

In a U-shape groove of 0.5 x 0.5 x 0.5 m, side grooves of 1 - 20 L/min in the flow rate of a domestic waste water of about 200 households were treated by the purifying apparatus of the invention exemplified in Figs.2a, 2b and Fig.4. Qualities of the original water and the treated water are as shown in Table 1.

Table 1

	Original water	Treated water
COD <sub>Cr</sub>	45-50	1-2
T-N	20-30	2-3
NH <sub>3</sub> -N	18-25	1-2
NO <sub>3</sub> -N	3-5	0.1-0.2
T-P	3-5	0.1-0.2
SS	40-45	5-10

unit:mg/l

Operating conditions are as shown in Table 2.

Table 2

Voltage	4kV - 10kV
Electric current	2 - 10mA
Frequency	50 - 75kHz
Water depth*	10cm
Electrode (plus)	Titanium oxide (porous titanium base plate)
Electrode (minus)	SUS (stainless plate)

\* : Dammed

Further, concentrations of the generated gasses are as shown in Table 3, and the gas after having been catalyst-treated by means of nickel and copper by a hydrogen addition was decreased in its noxious gasses, and their contents were in the order of traces.

### Table 3

	Generated gas	After H <sub>2</sub> -treatment
CO <sub>2</sub>	50 - 60%	50 - 60%
O <sub>2</sub>	1 - 2%	100 - 300 ppm
CO	0.1 - 0.2	10 - 20 ppm
N <sub>2</sub>	50 - 60%	50 - 60%
NO <sub>x</sub>	300 ppm	10 ppm,
SO <sub>x</sub>	0.01 - 0.02%	3 - 5%

< Embodiment 2 >

A life waste water (sewage) in Tsukuba-City was treated. As the positive electrode plate, there was used one in which a  $\text{TiO}_2$  particles sol was partially applied to a surface of porous ceramics having a porosity of 30% such that its thickness became 2 - 3 mm, the ceramics is sintered at 500 - 600°C after being dried, and the applied portion was made an electrode face.

The gas generated by the decomposition was caused to pass through the air and thereafter collected.

Results of the treatment during two months of November to December are shown in Table 4.

Table 4

Flow rate (m <sup>3</sup> /hr)		TOC (mg/L)	T•N (mg/L)	T•p (mg/L)	SS (mg/L)
0.60	Original water	13.2±5.0	10.3±3.8	1.0±0.5	30±8
	Treated water	3.0±1.0	1.5±0.5	0.04±0.01	2±1
1.23	Original water	12.5±5.0	10.1±3.5	1.2±0.6	32±8
	Treated water	2.5±1.0	1.8±0.8	0.08±0.02	3±1.5

Section: 50cm x 75cm    Water depth: 30cm    Normal pressure: 5kv, 10kHz,  
Duty ratio: 5%    Positive electrode: TiO<sub>2</sub>    Negative electrode: Ti (Thickness  
3mm)

Also in case where ruthenium oxide, cobalt oxide, nickel oxide and tin oxide were used in place of TiO<sub>2</sub>, approximately similar results were obtained.

As detailedly explained above, by the invention, the effective elimination of the water pollution substances such as nitrogen and phosphorous which have hitherto been difficult to be eliminated becomes possible, so that it is made possible to perform the purification of the flow such as river with a high efficiency.

What is claimed is:

1. A purifying apparatus for flowing water in which a negative electrode plate is disposed on a flowing water bed and a positive electrode plate is disposed in an upper face oppositely to the negative electrode plate, characterized in that the positive electrode plate is adapted so as to be dipped below a water surface of the flowing water with floats being disposed at least any of front/back and left/right of the positive electrode plate in a flowing direction of the flowing water, in the positive electrode plate there is arranged means for disposing it to an opposed upper face position with respect to the negative electrode plate, and the positive electrode plate and the negative electrode plate are provided with an electric field generating means, so that water pollution substances contained in the flowing water are oxidized and decomposed by a generation of high electric field pulses.

2. A purifying apparatus of claim 1, wherein in the positive electrode plate there is arranged means for vertically moving it.

3. A purifying apparatus of claim 1 or 2, wherein there is arranged gas collecting means.

4. A purifying apparatus of claim 3, wherein the gas collecting means is arranged in a rear portion of the positive electrode plate in the flowing direction of the flowing water.

5. A purifying apparatus of claim 3 or 4, wherein the

gas collecting means is arranged in a positive electrode plate back face upper portion which is reverse to an opposing face of the negative electrode plate.

6. A purifying apparatus of any of claims 1 to 5, wherein the positive electrode plate has at least one of metal or metal oxide.

7. A purifying apparatus of any one of claims 1 to 6, wherein the positive electrode plate is a metal, a ceramics or a resin, or a composite body consisting of more than two of the formers.

8. A purifying apparatus of any one of claims 1 to 7, wherein the positive electrode plate is a porous plate.

9. A purifying apparatus of any one of claims 6 to 8, wherein a positive electrode substance is at least one of titanium oxide, ruthenium oxide, cobalt oxide, nickel oxide, tin oxide and platinum.

10. A purifying apparatus of any one of claims 7 to 9, wherein a plate of porous titanium, porous ceramics or stainless is made a base plate in the positive electrode plate.

11. A purifying apparatus of any one of claims 6 to 10, wherein plural positive electrode face portions each having a positive electrode substance are arranged in the positive electrode plate.

12. A purifying apparatus of any one of claims 1 to 11, wherein the positive electrode plate has a concave curved face

opposite to the negative electrode plate.

13. A purifying apparatus of any one of claims 1 to 12, wherein gas seal means is arranged in the positive electrode plate.

14. A purifying apparatus of claim 13, wherein the gas seal means is arranged in a positive electrode plate back face which is reverse to the opposing face of the negative electrode plate.

15. A purifying apparatus of any one of claims 2 to 14, wherein the positive electrode plate is adapted by the vertically moving means such that its dipped depth from the water surface is  $1/5 - 1/10$  of a water depth.

16. A purifying apparatus of any one of claims 1 to 15, wherein a stainless plate or a metal plate to which a platinum foil coating has been applied is made the negative electrode plate.

17. A purifying apparatus of any one of claims 2 to 16, wherein the means for vertically moving the positive electrode plate in a gravity direction is provided with a differential transformer, thereby constituting a control mechanism for changing a voltage between faces of the positive electrode plate and the negative electrode plate between 200 V/cm and 10 KV/cm.

18. A purifying apparatus of any one of claims 1 to 17, wherein a turbidity detector is provided in front of a flowing

water flow with respect to the positive electrode plate, thereby constituting an automatic control mechanism for changing an electric current value between 1 mA and 100 mA in compliance with the turbidity.

19. A purifying apparatus of any one of claims 1 to 18, wherein a flow velocity meter is installed in the flowing water, thereby constituting an automatic control mechanism for changing a frequency between 10 kHz and 150 kHz from the flow velocity.

20. A purifying apparatus of any one of claims 1 to 19, wherein a plurality of metal made protrusions are provided on the electrode plate of at least one of the positive electrode plate and the negative electrode plate, and a structure by which the flowing water forms a turbulent flow is obtained by causing a height of the protrusion to be 10 - 15% of a distance between the positive electrode plate and the negative electrode plate.

21. A purifying apparatus of any one of claims 1 to 20, wherein there is provided a mechanism for manually or automatically cleaning a surface portion or surface portions of one or both of the positive electrode plate and the negative electrode plate by a high pressure water jetting unit or a roll brush.

22. A purifying apparatus of any one of claims 3 to 21, wherein the gas collecting means has a gas reservoir, and there is provided a mechanism for sucking a gas in the gas reservoir



by a water pressure, a suction pump or a blower, mixing the gas with hydrogen gas by an electrolysis or hydrogen gas by a hydrogen bomb, and reducing the gas to N<sub>2</sub> and water by a catalyst.

23. A purifying apparatus of any one of claims 1 to 22, wherein there is adjunctively provided, together with a unit for collecting and separating sediments generated by a suspension, a sedimentation tank decreasing the flow velocity in a rear of the unit in the flowing direction, or there is adjunctively provided a system in which a water flow is dammed and a part thereof is pumped up by a pump so as to be bypassed from the water flow and the sediments are sedimented in a gravity sedimentation tank, and a supernatant liquid is returned to an original river.

24. A purifying apparatus of any one of claims 2 to 23, wherein there is provided an emergency evacuation unit for lifting up the vertically moving means in an upward direction by an oil pressure or an electric motor at an abnormal flow rate time such as a flood.

25. A purifying method for flowing water, characterized in that the flowing water is treated by using an apparatus of any of claims 1 to 24.

## ABSTRACT OF THE DISCLOSURE

A purifying apparatus for flowing water in which a negative electrode plate is disposed on a flowing water bed and a positive electrode plate is disposed in an upper face oppositely to the negative electrode plate, wherein the positive electrode plate is adapted so as to be dipped below a water surface of the flowing water with floats being disposed at least any of front/back and left/right of the positive electrode plate in a flowing direction of the flowing water, in the positive electrode plate there are arranged means for disposing it to an opposed upper face position with respect to the negative electrode plate and, in compliance with a necessity, means for vertically moving the positive electrode plate and gas collecting means, and the positive electrode plate and the negative electrode plate are provided with an electric field generating means. And, by constituting the purifying apparatus such that water pollution substances contained in the flowing water are oxidized and decomposed by a generation of high electric field pulses, the water pollution substances such as nitrogen and phosphorous having been difficult to be effectively eliminated are eliminated from an inside of the flowing water.

Fig. 1

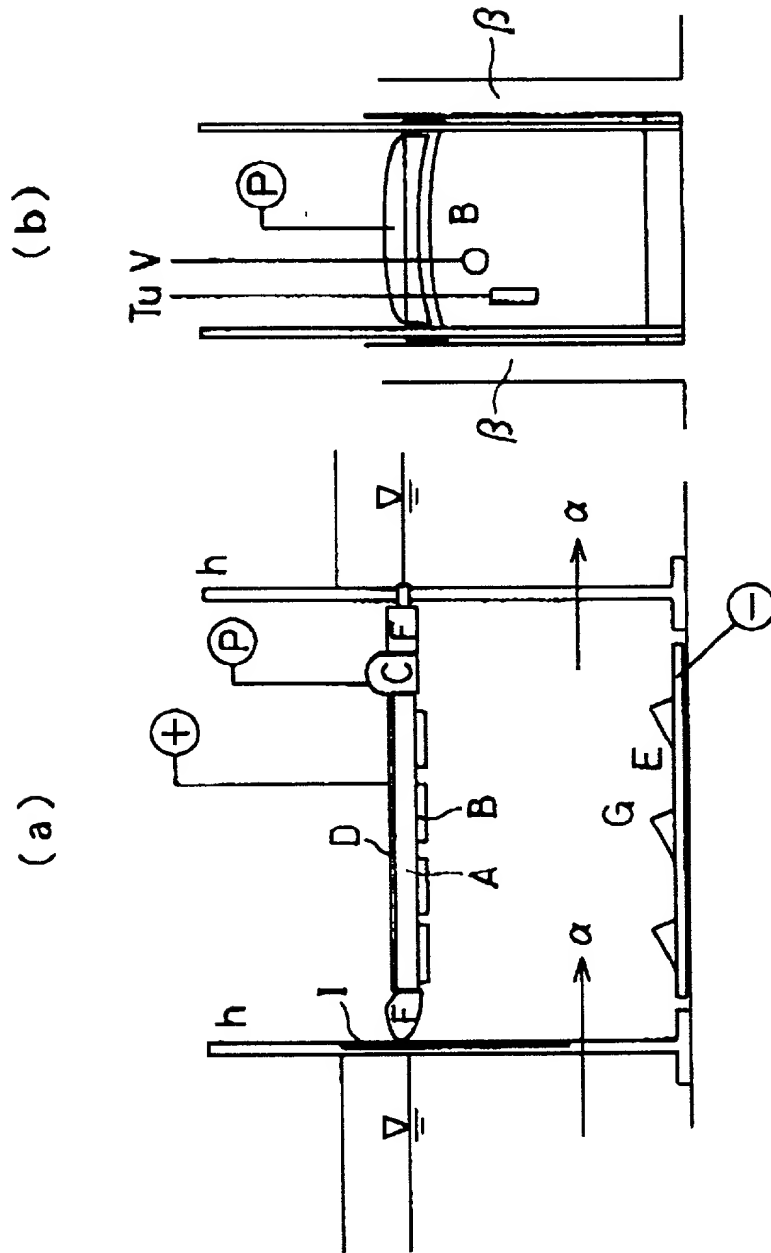




Fig. 3

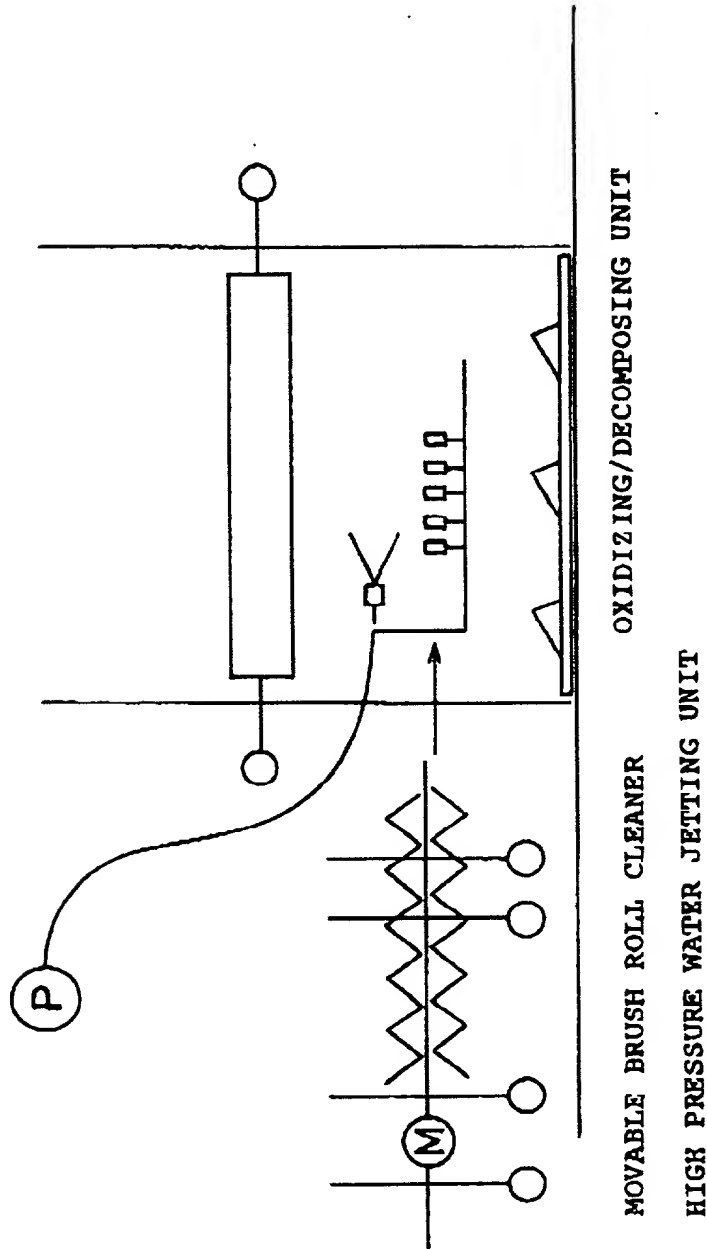


Fig. 4

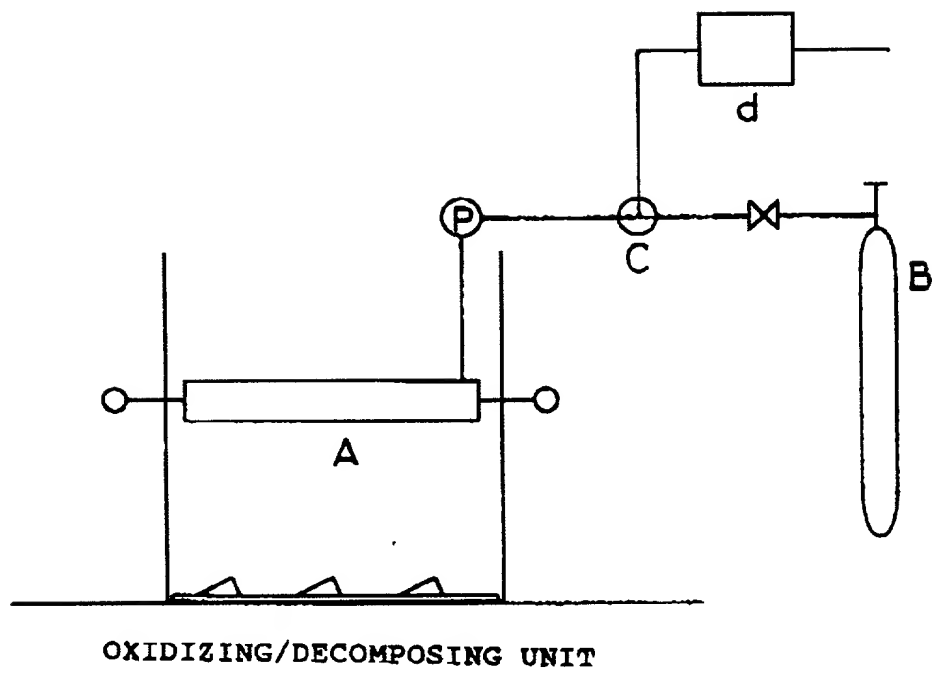
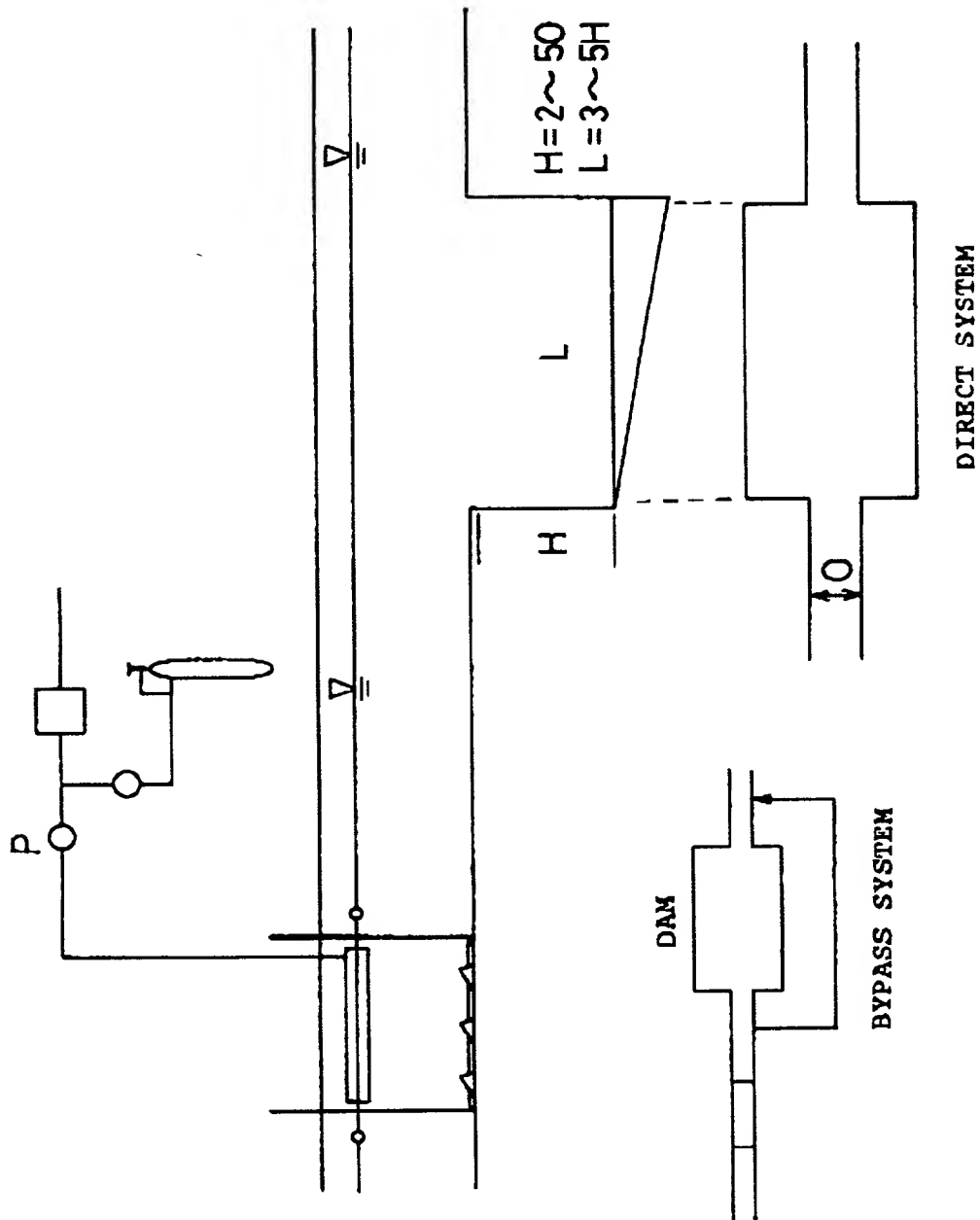


Fig. 5



Rev. 11-3/98

Effective March 1998



## DECLARATION AND POWER OF ATTORNEY FOR U.S. PATENT APPLICATION

☐ Original ☐ Supplemental ☐ Substitute ☒ PCT ☐ DESIGN

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: PURIFYING APPARATUS

of which is described and claimed in:

☐ the attached specification, or  
☐ the specification in application Serial No. \_\_\_\_\_, filed \_\_\_\_\_, and with amendments through \_\_\_\_\_ (if applicable), or  
☒ the specification in International Application No. PCT/JP00/02541, filed April 19, 2000, and as amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the content of the above-identified specification, including the claims, as amended by any amendment(s) referred to above.

I acknowledge my duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code, §119 (and §172 if this application is for a Design) of any application(s) for patent or inventor's certificate listed below and have also identified below any application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NO.	DATE OF FILING	PRIORITY CLAIMED
Japan	110911/1999 ✓	April 19, 1999 ✓	YES ✓

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NO.	U.S. FILING DATE	STATUS: PATENTED, PENDING, ABANDONED

6- And I hereby appoint Michael R. Davis, Reg. No. 25,134; Matthew M. Jacob, Reg. No. 25,154; Jeffrey Nolton, Reg. No. 25,408; Warren M. Cheek, Jr., Reg. No. 33,367; Nils Pedersen, Reg. No. 33,145; and Charles R. Watts, Reg. No. 33,142, who together constitute the firm of WENDEROTH, LIND & PONACK, L.L.P., jointly and severally, attorneys to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith.

I hereby authorize the U.S. attorneys named herein to accept and follow instructions from NISHIZAWA & ASSOCIATES as to any action to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and myself. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by me.

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I further declare that all statements made herein of my own knowledge are true, and that all statements on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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6th Inventor \_\_\_\_\_ Date \_\_\_\_\_

The above application may be more particularly identified as follows:

U.S. Application Serial No. \_\_\_\_\_ Filing Date December 18, 2000

Applicant Reference Number 99-F-050PCT-US/NT Atty Docket No. 2000 1716A

Title of Invention PURIFYING APPARATUS